

## Civilian Penetrating Wounds of the Abdomen \*

### I. Factors in Mortality and Differences from Military Wounds in 494 Cases

HARWELL WILSON, M.D., ROGER SHERMAN, M.D.

*From the Division of Surgery, University of Tennessee, Memphis, Tennessee*

INTENSE INTEREST of surgeons in management of war wounds of the abdomen is indicated by publication of over 300 articles on this subject from January 1940 to June 1946 (World War II)<sup>7</sup> and further reflected by reduction in mortality of abdominal war wounds from 53.5 per cent in World War I,<sup>18</sup> and 25 per cent in World War II,<sup>3</sup> to 12 per cent in Korea.<sup>1</sup>

Between wars similar steady reduction in civilian mortality from wounds of the abdomen has been achieved.<sup>9, 10</sup> This parallel declining mortality makes comparison of results between military and civilian patients attractive.<sup>11</sup>

Civilian surgeons become successful military surgeons by recognition (or directive) that standards of management applicable in civilian wounds often do not effect similar results in war wounds.<sup>19</sup> Military surgeons, after armistice, become civilian surgeons and assume responsibility for teaching standards of management to the next generation of surgeons. It follows, that military standards of management tend to become civilian standards whether they are especially indicated for civilian wounds or not.

Mortality comparison between military and civilian patients with abdominal wounds, without emphasis of the differences, provides little useful information for improvement in management of either type of patient, as war and civilian wounds of the abdomen have almost nothing in common. Type of patient, age, wounding

instrument, velocity, type of wound, locale, type of transport after injury, time lag from injury to treatment, associated injuries, facilities for preliminary, operative and postoperative care, average blood loss, number of patients requiring treatment, organs injured, cause of death, even the consistency of colon contents, are but a few of the differences.

Surgeons of large experience with both military and civilian patients have recently emphasized benefits of differences in technical management between the two groups in colon injuries.<sup>12</sup> Further, differences in general principles of management, e.g. less frequent laparotomy for nonconfirmed perforating abdominal wounds, has been recently urged.<sup>14</sup>

After 1946, most authorities agree that such general measures as adequate blood replacement, early surgical exploration, antibiotic therapy, and careful postoperative care have been responsible for the major portion of reduction in mortality of abdominal wounds both in civilian and military cases.

Excluding contributions to management of injuries of major blood vessels,<sup>6</sup> specific surgical technics have not changed appreciably over a number of years and are, consequently, not as influential in reduction of mortality as improvements in general measures of treatment.

Correlation of some of the variables contributing to mortality in civilian abdominal wounds, with emphasis on their differences from military wounds, is the basis of this report.

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TABLE 1. *Penetrating Abdominal Wounds. Age—Sex—and Race Distribution. J.G.H.—1948–1959—452 Cases.*

Type	Male	Female	Negro	White	Peak Age (Extremes)	Total
Stab	215	47	248	14	20–30 (1–64)	262
Gunshot	152	38	172	18	20–30 (3–67)	190
Totals	367	85	420	32	20–30 (1–67)	452

### Material

From 1948 through 1959 inclusive, 494 patients with abdominal wounds were admitted to John Gaston Hospital. Twenty-seven patients with thoraco-abdominal wounds previously reported<sup>15</sup> and 15 with extraperitoneal perforations of the rectum to be included in a subsequent report were excluded. Mortality of 452 remaining cases alive on admission was 9.6 per cent. Fifty-eight per cent of total cases were stab-bings, and 42 per cent were gunshot wounds. Ninety-three per cent of patients were Negro. Stab wounds were more common among Negroes and gunshot wounds more common in white patients. The peak age range of incidence was between 20–30 years with extremes of one to 67 years. Eighty-one per cent of patients were males, and 19 per cent were females (Table 1).

### Treated Cases

To evaluate results of treatment, 16 patients failing to survive more than one hour following admission; three transferred to other hospitals after resuscitation, and one refusing treatment were not included. Two

additional patients—one, admitted seven days after exploratory laparotomy elsewhere for gunshot wounds of the aorta and iliac arteries treated by gauze pack, who died, and one admitted five days post-operative with a surgical clamp retained in the peritoneal cavity—who survived, were also excluded. Four hundred thirty (256 stab and 174 gunshot) patients with 25 deaths (5.8%) remain for analysis (Table 2). Mortality in other series of civilian abdominal wounds since the Korean War range from 6.4 to 7.8 per cent<sup>8, 9, 14, 16</sup> (Table 3).

### Diagnosis of Perforation

Careful evaluation of physical findings was not always sufficient to establish the diagnosis of absence of perforation. Local exploration, by enlarging wounds of entrance, was a reliable method for demonstrating penetration, but of little value in determining perforation. Probing wounds of entrance with instruments was not reliable.

Laboratory findings, useful as base line information, are of little value in aiding diagnosis of perforation. No reliable correlation of visceral injuries including those with major blood loss with white blood cell count, hematocrit, or hemoglobin determinations was demonstrated.

Three hundred twenty-seven patients (79%) had routine x-ray examination of the abdomen and 12 others had special diagnostic studies, e.g. cystogram, pyelogram, etc. X-ray findings aided (x-ray

TABLE 2. *Mortality—Treated Cases—(430 Cases)*

Type	No. Cases	Deaths	% Mortality
Stab	256	8	3.1
GSW	174	17	9.8
Total	430	25	5.8

TABLE 3. *Mortality—Comparison with Recent Series*

Authors	Date	No. Cases	% Mortality
Sherman	1956	212	7.8
McComb <i>et al.</i>	1958	307	6.4
Moore <i>et al.</i>	1959	109	6.4
Shaftan	1960	180*	6.4
Present report	1960	430	5.8

\* 112 Stab or GSW.

diagnosis confirmed at laparotomy) diagnosis of perforating wounds in 27 (8.3%) of cases, hindered (x-ray diagnosis not confirmed at laparotomy) diagnosis in seven, (2.4%) of patients, and were of no diagnostic value (x-ray diagnosis negative for perforation) in 293 (89.6% of cases). Reliance on x-ray findings for establishing diagnosis of perforation in most civilian cases seems unjustified on the basis of this study (Table 4).

Effects of additional transport for x-ray examination of patients with abdominal wounds, especially those in compensated oligemic shock, should be weighed against the contribution of x-ray examination to treatment of abdominal wounds.

Ziperman<sup>10</sup> has emphasized the value of preoperative x-ray examination for localization of foreign bodies within the abdomen in war wounds. Since 76 per cent of penetrating wounds of the abdomen in Korea were caused by fragmentation missiles,<sup>9</sup> x-ray demonstration of these multiple small fragments is valuable, not so much for diagnosis of perforation, as for indicating anatomic regions of the abdomen requiring extra attention during exploration.

Less than 12 per cent of civilian wounds are caused by multiple small missiles

TABLE 4. *X-Ray—Value in Diagnosis—(327 Cases)*

Diagnostic Value	No. Cases	% of Total
Aided diagnosis	27	8.3
Hindered diagnosis	7	2.1
No diagnostic value	293	89.6
Totals	327	100

(shotgun). Localization of the usual relatively large civilian pistol or rifle slugs prior to operation is of little value, as thorough examination of all abdominal organs is already indicated.

Early laparotomy following initial evaluation and resuscitation was the best method of establishing the presence or absence of perforating wounds of the abdomen in our patients.

One hundred twenty-four patients (93 stab and 31 gunshot) had abdominal exploration with no perforation found. One patient died post operatively from an iatrogenic 360-degree volvulus of the small bowel, which could well have occurred with or without a perforating wound. Total mortality in patients with negative findings at exploratory laparotomy was 0.8 per cent (Table 5). Much higher mortality rates following laparotomies for war wounds without perforation are reported<sup>13</sup> again emphasizing differences in cases.

Three stab patients and 24 gunshot wounds, believed to be nonperforating, were managed without laparotomy. One patient died with sepsis from perforating wounds of the jejunum. Mortality in patients believed to have nonperforating

TABLE 5. *Laparotomy—No Perforation Found (124 Cases)*

Type	No. Cases	% Total Cases	Deaths	% Mortality
Stab	93	36.6	1	1.1
GSW	31	17.9	0	0
Totals	124	28.9	1	0.8

TABLE 6. *No Laparotomy—(27 Cases) Accuracy of Diagnosis and Results*

Type	No. Cases	Deaths	% Mortality
Stab	3	1	33.3
GSW	24	0	0
Totals	27	1	3.7

wounds treated without exploration was 3.7 per cent (Table 6).

Most civilian series concerned with negative exploratory laparotomy show a lower mortality than that found in military reports. Even a report which urges watchful waiting when findings of perforation are not definitely established, evidences higher mortality in cases managed without exploration than for negative laparotomies.<sup>14</sup> Differences in mortality support the concept that laparotomy for abdominal wounds with possible perforation is justified.

### General Measures of Treatment

Seventy-two per cent of patients were given blood prior to, during, and after operation, and intestinal decompression by Levin tube was recorded in 83% of cases. Ninety-five per cent of cases surviving operation and all patients managed without exploration received antibiotics. Seventy-four per cent of patients were treated by combinations of two antibiotics (penicillin and streptomycin 62%).

TABLE 7. *Etiology and Mortality (266 Known Cases)*

Weapon	No. Cases	Deaths	% Mortality
Shotgun	49	10	20.4
Pistol	101	17	16.8
Ice pick	14	2	14.3
Butcher knife	15	2	13.3
Rifle	26	2	7.7
Switch-blade knife	17	1	5.9
Pocket knife	44	0	0
Totals	266	34	12.7

### Factors Influencing Mortality

Seven factors influencing mortality from abdominal wounds, patient's age, etiology, time lag from injury to treatment, blood loss, multiplicity of organs injured, specific organ injury, and complications of treatment were evaluated.

**Age.** Forty years was selected as the age limit for evaluation of mortality to emphasize differences in ages between civilian and military cases. Less than two per cent (exclusive of Koreans) of patients with abdominal wounds treated in Korea were over age 40.<sup>2</sup> Seventy patients (16.3%) were 40 years or older. Mortality was 4.3 per cent in this group. Three hundred sixty patients (83.7%) were less than 40 years old. Mortality in this group was 6.1 per cent. Twelve per cent of total deaths were in patients over age 40.

**Etiology.** The etiology of wounds was known in 226 patients alive on admission. Ten of 49 patients (20%) died from shotgun wounds, and 17 of 101 (16.8%) died from wounds of pistols of various calibers.

Two of 14 patients (14.3%), third highest after shotgun and pistol, died from ice pick wounds. The high percentage of total deaths from ice pick injuries emphasizes that lethal perforating wounds of the abdomen frequently result from small diameter, low velocity weapons.

Fourteen patients had gunshot wounds of unknown caliber. However, there were clearly no injuries produced by bullets of military velocity. Nearly all (94.8%) fatalities in our series were due to wounds produced by weapons rarely seen in military combat. (Table 7).

**Time Lag—Injury to Treatment.** Forty-one per cent of patients dying were treated within four hours of injury, and 92 per cent were treated within eight hours. One patient, treated 17 hours after injury died from peritonitis secondary to delay post injury in reporting for care. There are too few patients treated more than eight hours

TABLE 8. *Multiple Organs and Mortality—(275 Cases)*

No. Organs	Stab	GSW	Total Deaths	% Total Deaths
1	0	0	0	0
2	4	1	5	23.8
3	1	5	6	28.6
4	1	3	4	19.0
Over 4	0	6	6	28.6
Totals	6	15	21	100

following injury to draw conclusions. However, those patients treated within eight hours showed no significant difference in mortality when compared with those treated within 40 hours.

### Blood Loss

The importance of sufficient volume replacement in patients with abdominal wounds needs no further emphasis. Transfusion records of 430 treated cases indicate that 63.8 per cent of patients with gunshot and 69.5 per cent with stab wounds received blood transfusions. Patients with gunshot wounds received an average of 1,582 cc. of blood, and those with stab wounds an average of 937 cc.

Fifty-four per cent of patients dying received from 2,000 to 4,000 cc. Two deaths from bleeding were related to poor evaluation of blood loss and under transfusion. Military patients require over four times (average, 6,623 cc. per patient<sup>13</sup>) as much blood as civilian patients with abdominal wounds.

### Multiple Organ Injury

For analysis of influence of multiple organ injuries on mortality, four deaths were excluded. Two with only one organ injured (one aorta, one vena cava), one with negative laparotomy, and one dying without exploration.

Of 21 remaining deaths, no patient died from a single injury. Five deaths were in patients with two organs injured (23.8%), six with three (38.6%), four with four

(19%), and six with more than four organs injured. The percentage of total deaths in patients with two, four and over four organs injured are nearly identical. Nine of 256 surviving patients had injuries of more than four organs, a case fatality rate of 40% (Table 8).

### Individual Organ Injury and Mortality

The influence of individual organ injury on mortality reflects, in part, effectiveness of technics of management of each specific organ injury. Method of management of individual organ injuries is included for cases in which management of individual injury contributed directly to mortality. Influence of methods of management of individual organs on survival correlated with a number of variables in these cases is the basis of a separate report.

Only three of 403 patients (one death) had visceral injury missed at initial exploration. Two patients, both with multiple perforating gunshot wounds of the small bowel missed at initial exploration, survived reoperation with closure of the missed perforations.

Wounds of the aorta produced fatal hemorrhage in each of two patients. One of three patients with wounds of the vena cava also died of blood loss. The incidence of injury of aorta and vena cava in our patients is more than twice that reported in military cases.<sup>4, 5</sup>

Mortality from wounds of the biliary tract (gallbladder and extra hepatic ducts) were as lethal as wounds of the vena cava.

TABLE 9. *Mortality—Visceral Injury—(279 Cases)*

Injury	Type		Cases	Wounds	Deaths	% Mortality
	Stab	GSW				
Aorta	0	2	2	2	2	100
Vena cava	1	2	3	3	1	33.3
Biliary	2	4	6	6	2	33.3
Duodenum	2	17	19	22	5	26.3
Pancreas	7	3	10	10	2	20
Urinary bladder	0	12	12	14	2	16.7
Kidney	6	14	20	20	3	15
Vascular	12	9	17	17	2	11.8
Colon	18	68	86	98	10	11.6
Small bowel	34	58	92	521	10	10.9
Spleen	9	10	19	19	2	10.5
Stomach	35	19	54	67	5	9.3
Liver	63	44	107	112	7	6.5
Uterus	1	2	3	3	0	0

There were no deaths in four patients with uncomplicated perforating injuries of the gallbladder or common duct. Two deaths were in patients with additional duodenal or pancreatic injury related to complications frequently seen in combined wounds of these organs.

Wounds of the colon were associated with mortality about equally as often as wounds of small bowel, spleen, blood vessels (excluding aorta and vena cava). Deaths in patients with colon wounds occurred less often than deaths in patients with eight other organ injuries. Higher mortality from abdominal wounds<sup>17</sup> associated with colon injury was not seen in our cases. Injury of the liver was associated with the lowest mortality excluding the uterus which was injured on three occasions (Table 9).

#### Analysis of Causes of Death

There were 25 deaths in 430 treated cases, a mortality of 5.8 per cent. Deaths were classified as related to hemorrhage (primary and secondary), complications (including sepsis), massive wounds with multiple lethal factors involved (close range shotgun), deaths of undetermined cause, and others.

Seven patients (28%) died from com-

plications not directly related to factors considered in this analysis or to methods of surgical management. It is hoped that influence on mortality and morbidity of surgical management of individual organ injuries in civilian practice will be further clarified by another study now in process of preparation.

Three of the seven deaths attributed to complications were, one from renal failure, one from cardiac arrest, and one from pulmonary embolism. Four others were due to sepsis, two associated with injuries of the pancreas and duodenum, and two related to delay in admission or diagnosis.

Nine patients (36%) died of either primary or secondary hemorrhage. Three patients treated early in the series for perforating wounds of the aorta or vena cava died following tamponade treatment with gauze packs. (Since 1959, four patients not included in this report have had successful suture of wounds of the aorta and vena cava.) Three other deaths were related to secondary hemorrhage—one, 14 days postoperative from a stab wound of the renal vein, one from the splenic pedicle following splenectomy in a patient with associated traumatic pancreatitis, and one from wounds of the abdominal wall.

Two patients died from hemorrhage prior



to operation. In retrospect it would seem, they were probably given inadequate replacement transfusions. One patient died during laparotomy from a large hemothorax secondary to an abdomino-thoracic wound not recognized preoperatively.

Five deaths (20%) followed close range shotgun injuries productive of massive soft tissue as well as visceral wounds, in which no single factor was responsible for death. Cause of death in three patients (12%) was undetermined. One patient (4%) died with an iatrogenic 360-degree volvulus of the small bowel following negative exploratory laparotomy (Table 10).

With the exception of death from massive hemorrhage, only two patients treated by operation died of causes (peritonitis) encountered in war wounds of the abdomen.<sup>13</sup>

### Conclusions

So many variables influence case fatality rate in abdominal wounds, analysis of large numbers of cases becomes a necessity for valid conclusions. Large numbers of patients are readily available during war. Steady improvement in case fatality rate in war wounds of the abdomen has resulted, in part, from conclusions drawn from analysis of factors influencing case fatality rate in combat cases. Possibly because large numbers of patients with penetrating wounds of the abdomen are in general not common in civilian practice, the tendency to consider military wounds and their management as standards for civilian patients is quite prevalent.

Factors influencing mortality could be analyzed in 452 patients treated at the John Gaston Hospital during a time period short enough to have such general measures as sufficient blood, antibiotics, and facilities for early treatment available in comparable measure for all patients.

Comparison of factors influencing mortality in this civilian series with military series in which similar general measures

TABLE 10. *Mortality—Analysis of Cause (25 Cases)*

Cause of Death	Cases	%
Hemorrhage (primary and secondary)	9	36
Complications (including sepsis)	7	28
Massive wounds (Close range shotgun)	5	20
Undetermined	3	12
Others (small bowel obstruction)	1	4
Totals	25	100

of management were available, reveal striking dissimilarity of factors responsible for case fatality rate. Near absence of major factors in common between war and civilian wounds of the abdomen suggests that further improvement in civilian mortality will depend on measures more suited to civilian patients.

### Summary

1. Four hundred ninety-four cases of penetrating abdominal wounds admitted from 1948 through 1959 inclusive were analyzed for differences from war wounds and for factors contributing to mortality. Four hundred thirty patients, with wounds limited to the abdomen, remained for analysis after thoraco-abdominal wounds, deaths prior to treatment, and wounds not involving the peritoneal cavity, were excluded.

2. Fifty eight per cent of patients had stab and 42 per cent had gunshot wounds. Nearly all (94.8%) wounds in our patients were produced by weapons rarely used in military combat.

3. Mortality was 0.8 per cent in patients with negative laparotomy and 3.7 per cent in patients thought not to have perforating wounds treated without laparotomy. Diagnostic x-ray examination of the abdomen was inconclusive in over 85 per cent of 327 cases.

4. Mortality was 5.8 per cent (25 patients) in 430 treated cases.

5. Age, etiology, time lag, blood loss, multiple organ injury, specific organ injury and complications were evaluated as factors in mortality, and compared with military cases. Influence of specific treatment on mortality and morbidity of individual organ injury was not included in this report. Factors contributing to mortality, as well as other factors evaluated in our cases were not comparable to those reported in military series.

6. Further improvement in mortality and morbidity in civilians will depend on further study of civilian cases with revision of military standards of treatment not applicable for civilian wounds.

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### DISCUSSION

DR. DAVID HENRY POER: Dr. Wilson, as is his custom, has given an informative presentation in a pleasant and entertaining manner. He has left very little for any of us to say. He was kind enough to mention to me that he would present this paper at this time, knowing my interest in

this particularly topic, particularly at the end of World War II, at which time we reviewed the figures for many of the field units during the war.

Up to World War II, the mortality rate for penetrating wounds of the abdomen was extremely high. In fact, one could go back a relatively short time, and find that the mortality of 90 to 95 per cent was not unusual. Prior to World